GCE AS/A Level

0980/01

S17-0980-01

MATHEMATICS – M1
Mechanics

TUESDAY, 20 JUNE 2017 – AFTERNOON

1 hour 30 minutes

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- a WJEC pink 16-page answer booklet;
- a Formula Booklet;
- a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Answer **all** questions.

Take g as $9{\cdot}8\,\text{ms}^{-2}$.

Sufficient working must be shown to demonstrate the **mathematical** method employed.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

1. *(a)* When a lift is ascending with an acceleration of a ms^{-2}, the tension in the lift cable is 15 000 N. The total mass of the lift and its contents is 1200 kg. Determine the value of a. [3]

(b) A crate on the floor of another lift has mass 50 kg. The lift is descending with an acceleration of 0·2 ms^{-2}. Find the magnitude of the reaction of the floor on the crate. [3]

2. Two smooth spheres *P* and *Q*, of equal radii and of masses 6 kg and 2 kg respectively, are moving towards each other on a smooth horizontal table. Before collision, the speed of *P* is 5 ms^{-1} and the speed of *Q* is 3 ms^{-1}. After collision, the direction of motion of *Q* is reversed and it moves with speed 7·5 ms^{-1}.

(a) Find the magnitude of the impulse exerted by *P* on *Q*. [2]

(b) Determine the speed of *P* after the collision. [3]

(c) Calculate the coefficient of restitution between *P* and *Q*. [3]

(d) After the first collision, sphere *Q* collides with a wall which is perpendicular to its direction of motion. The coefficient of restitution between sphere *Q* and the wall is 0·6. Determine the speed of *Q* after it has rebounded from the wall. [2]

3.

The diagram shows a uniform plank *AB*, of mass 20 kg and length 2·4 m, supported in horizontal equilibrium by two pivots, one at *C* and one at *D*. The distance *AC* and the distance *DB* are both 0·5 m. A person of mass 40 kg stands at a point which is 0·6 m from *B*.

(a) Calculate the magnitudes of the reaction at *C* and the reaction at *D*. [7]

(b) The person starts to walk towards *A*. Determine the greatest distance of the person from *B* if equilibrium is to be maintained. [3]

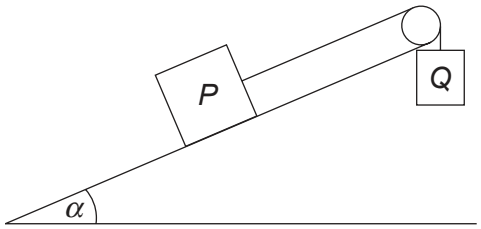
4. A car of mass 800 kg is travelling on a horizontal road. It experiences a resistance to motion which is constant throughout the journey. The car accelerates from rest under a constant tractive force of 300 N exerted by its engine. After 50 seconds, the car reaches a speed of 15 ms^{-1}.

(a) Determine the magnitude of the acceleration of the car. [3]

(b) Calculate the magnitude of the constant resistance to motion. [3]

(c) When the car reaches the speed of 15 ms^{-1}, the engine is switched off and the car is brought to rest by a constant braking force. The total distance covered by the car for the **whole** journey is 500 m. Find the constant force exerted by the brakes. [7]

5. Two particles *P* and *Q*, of masses 6 kg and 4 kg respectively, are connected by a light inextensible string of length 2 m. The string passes over a light smooth pulley fixed at the top of a smooth plane which is inclined at an angle α to the horizontal where $\sin\alpha = \frac{3}{5}$.



Initially, the particles are held at rest with the string just taut, with particle *P* lying on the plane and particle *Q* hanging just over the pulley. The particles are then released.

(a) Find the magnitude of the acceleration of the particles and the tension in the string. [6]

(b) Given that particle *Q* is initially 1·5 m above the ground, determine the speed with which particle *Q* hits the ground. [3]

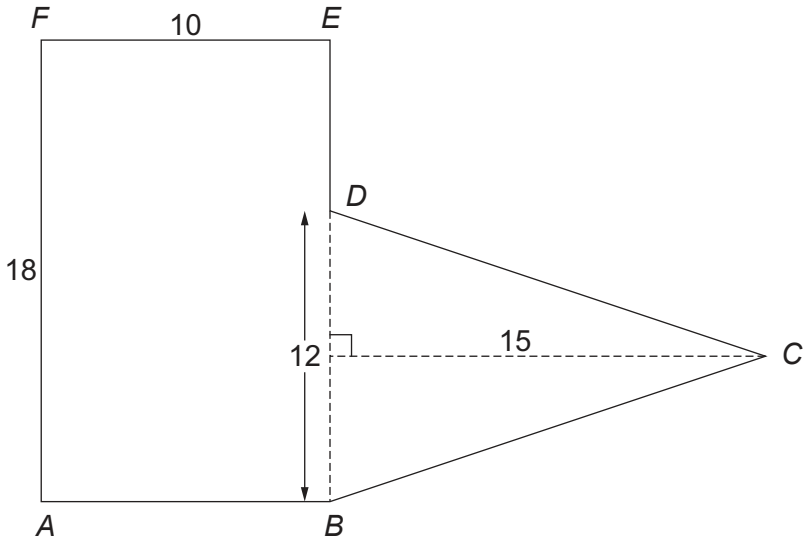
(c) Given that particle *P* does not reach the top of the plane, calculate the time that elapses between *Q* reaching the ground and the string becoming taut again. Give your answer correct to 2 decimal places. [4]

6. A light uniform rod *AB*, of length 3 m, has a particle of mass 2 kg attached to its midpoint and a particle of mass 0·8 kg attached to it at a distance 0·6 m from *B*. Another particle of mass 1·2 kg is attached to the rod at a distance of 0·5 m from *A*. Determine the distance of the centre of mass of the particles from *B*. [4]

TURN OVER

7. An object of mass 45 kg lies on a rough plane inclined at an angle α to the horizontal where $\tan\alpha = \frac{3}{4}$. A rope, attached to the object, is held parallel to the line of greatest slope of the plane. The coefficient of friction between the plane and the object is 0·5. The object remains stationary on the plane. Find the least and the greatest possible values of the tension in the rope. [9]

8. The diagram below shows a uniform lamina *ABCDEF*. The rectangle *ABEF* has sides *AF* = 18 cm and *EF* = 10 cm. The triangle *BCD* is isosceles with *BC* = *CD* and *BD* = 12 cm. The height of triangle *BCD* is 15 cm.



(a) Find the distances of the centre of mass of the lamina from *AF* and from *AB*. [7]

(b) The lamina is suspended freely from the point *E* and hangs in equilibrium. Calculate the angle *EB* makes with the vertical. [3]

END OF PAPER

